

1   **SECTION 6-18, SHOTCRETE FACING**

2   **April 5, 2004**

3   **6-18.1 Description**

4   This work consists of constructing shotcrete facing as shown in the Plans. Shotcrete  
5   constructed as concrete slope protection shall be constructed in accordance with Section 8-  
6   16.

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8   **6-18.2 Materials**

9   Materials shall meet the requirements of the following sections:

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11       Cement	9-01
12       Aggregates for Portland Cement Concrete	9-03.1
13       Premolded Joint Filler	9-04.1(2)
14       Steel Reinforcing Bar	9-07.2
15       Epoxy-Coated Steel Reinforcing Bar	9-07.3
16       Concrete Curing Materials and Admixtures	9-23
17       Fly Ash	9-23.9
18       Water	9-25

19

20   Other materials required, including materials for shotcrete, shall be as specified in the  
21   Special Provisions.

22  
23   **6-18.3 Construction Requirements**

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25   **6-18.3(1) Submittals**

26   The Contractor shall submit the following information to the Engineer at least 14 calendar  
27   days prior to beginning construction of the shotcrete facing:

- 28
- 29       1. The shotcrete mix design with compressive strength test results.
  - 30       2. Method and equipment used to finish and cure the shotcrete facing.
  - 31       3. Documentation of the experience of the nozzle operators in applying shotcrete.
- 32

33   The Contractor shall not begin construction of the shotcrete facing until receiving the  
34   Engineer's approval of the above submittals.

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36   **6-18.3(2) Mix Design**

37   Shotcrete shall be proportioned to produce a 4,000 psi compressive strength at 28 days.  
38   The Contractor shall submit the shotcrete mix design, proposed method of placement, and  
39   evidence that the proposed design and placement method will produce the desired  
40   compressive strength at 28 days, to the Engineer at least 14 calendar days prior to the  
41   anticipated beginning of shotcrete placement. Shotcrete placement will not be allowed until  
42   the Engineer has approved the mix design and method of placement.

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44   Admixture shall be used only after receiving permission from the Engineer. If admixtures are  
45   used to entrain air, to reduce water-cement ratio, to retard or accelerate setting time, or to  
46   accelerate the development of strength, the admixtures shall be used at the rate specified by  
47   the manufacturer and approved by the Engineer.

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### **6-18.3(3) Testing**

The Contractor shall make shotcrete test panels for evaluation of shotcrete quality, strength, and aesthetics. Both preproduction and production test panels, shall be prepared. All cores obtained for the purpose of shotcrete strength testing shall have the following minimum dimensions:

- a. The core diameter shall be at least 3 times the maximum aggregate size, but not less than 2 inches.
- b. The core height shall be a minimum of 1.5 times the core diameter.

The Contractor shall remove at least three cores from each 36-inch by 36-inch shotcrete test panel in accordance with AASHTO T 24. Cores removed from the panel shall be immediately wrapped in wet burlap and sealed in a plastic bag. Cores shall be clearly marked to identify from where they were taken and whether they are for pre-production or production testing. If for production testing, the section of the wall represented by the cores shall be clearly marked on the cores. Cores shall be delivered to the Engineer within 2 hours of coring. The remainder of the panels shall remain the property of the Contractor.

### **6-18.3(3)A Pre-production Testing**

At least one 36-inch by 36-inch panel for each mix design shall be prepared for evaluation and testing of the shotcrete quality and strength. One 48-inch by 48-inch qualification panel shall be prepared for evaluation and approval of the proposed method for shotcrete installation, finishing, and curing. Both the 36-inch and the 48-inch panels shall be constructed using the same methods and initial curing proposed to construct the shotcrete facing, except that the 36-inch panel shall not include wire reinforcement. The 36-inch panel shall be constructed to the minimum thickness necessary to obtain the required core samples. The 48-inch panel shall be constructed to the same thickness as proposed for the production facing. Production shotcrete work shall not begin until satisfactory test results are obtained and the panels are approved by the Engineer.

### **6-18.3(3)B Production Testing**

The Contractor shall make at least one 36-inch by 36-inch panel for each section of facing shot, or as many as directed by the Engineer. A section is defined as one day's placement. The production panels shall be constructed using the same methods and initial curing used to construct the shotcrete wall, but without wire reinforcement. The panels shall be constructed to the minimum thickness necessary to obtain the required core samples. If the production shotcrete is found to be unsuitable based on the results of the test panels, the section(s) of the wall represented by the test panel(s) shall be repaired or replaced to the satisfaction of the Engineer at no cost to the Contracting Agency.

### **6-18.3(4) Qualifications of Contractor's Personnel**

All nozzle operators shall have had at least one year of experience in the application of shotcrete. Each nozzle operator will be qualified, by the Engineer, to place shotcrete, after successfully completing one test panel for each shooting position and surface type which will be encountered.

Qualification will be based on a visual inspection of the shotcrete density, void structure, and finished appearance along with a minimum 7-day compressive strength of 2,500 psi determined from the average test results from two cores taken from each test panel.

1 The Contractor shall notify the Engineer not less than 2 days prior to the shooting of a  
2 qualification panel. The mix design for the shotcrete shall be the same as that slated for the  
3 wall being shot.

4  
5 Shotcrete shall be placed only by personnel qualified by the Engineer.

6  
7 If shotcrete finish Alternative B or C is specified, evidence shall be provided that all shotcrete  
8 crew members have completed at least three projects in the last five years where such  
9 finishing, or sculpturing and texturing of shotcrete was performed.

#### 10 11 **6-18.3(5) Placing Wire Reinforcement**

12 Reinforcement of the shotcrete shall be placed as shown in the Plans. The wire  
13 reinforcement shall be securely fastened to the steel reinforcing bars so that it will be 1 to  
14 1.5 inches from the face of the shotcrete at all locations, unless otherwise shown in the  
15 Plans. Wire reinforcement shall be lapped 1.5 squares in all directions, unless otherwise  
16 shown in the Plans.

#### 17 18 **6-18.3(6) Alignment Control**

19 The Contractor shall install non-corroding alignment wires and thickness control pins to  
20 establish thickness and plane surface. The Contractor shall install alignment wires at  
21 corners and offsets not established by formwork. The Contractor shall ensure that the  
22 alignment wires are tight, true to line, and placed to allow further tightening. The Contractor  
23 shall remove the alignment wires after facing construction is complete.

#### 24 25 **6-18.3(7) Shotcrete Application**

26 A clean, dry supply of compressed air sufficient for maintaining adequate nozzle velocity for  
27 all parts for the work and for simultaneous operation of a blow pipe for cleaning away  
28 rebound shall be maintained at all times. Thickness, method of support, air pressure, and  
29 rate of placement of shotcrete shall be controlled to prevent sagging or sloughing of freshly-  
30 applied shotcrete.

31  
32 The shotcrete shall be applied from the lower part of the area upwards. Surfaces to be shot  
33 shall be damp, but free of standing water.

34  
35 The nozzles shall be held at an angle approximately perpendicular to the working face and  
36 at a distance that will keep rebound at a minimum and compaction will be maximized.  
37 Shotcrete shall emerge from the nozzle in a steady uninterrupted flow. If, for any reason, the  
38 flow becomes intermittent, the nozzle shall be diverted from the work until a steady flow  
39 resumes.

40  
41 Surface defects shall be repaired as soon as possible after initial placement of the shotcrete.  
42 All shotcrete which lacks uniformity; which exhibits segregation, honeycombing, or  
43 lamination; or which contains any dry patches, slugs, voids, or sand pockets, shall be  
44 removed and replaced with fresh shotcrete by the Contractor, to the satisfaction of the  
45 Engineer at no cost to the Contracting Agency.

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47 Construction joints in the shotcrete shall be uniformly tapered over a minimum distance of  
48 twice the thickness of the shotcrete layer. The surface of the joints shall be cleaned and  
49 thoroughly wetted before adjacent shotcreting is performed. Shotcrete shall be placed in a  
50 manner which provides a finish with uniform texture and color across the construction joint.

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1 The shotcrete shall be cured by applying a clear curing compound in accordance with  
2 Section 9-23.2. The curing compound shall be applied immediately after final gunning. The  
3 air in contact with shotcrete surfaces shall be maintained at temperatures above 50F for a  
4 minimum of 7 days. Curing compounds shall not be used on any surfaces against which  
5 additional shotcrete or other cementitious finishing materials are to be bonded unless  
6 positive measures such as sandblasting, are taken to completely remove the curing  
7 compounds prior to the application of such additional materials.

8  
9 If field inspection or testing, by the Engineer, indicates that any shotcrete produced, fails to  
10 meet the requirements, the Contractor shall immediately modify procedures, equipment, or  
11 system, as necessary, and as approved by the Engineer to produce specification material.  
12 All substandard shotcrete already placed shall be repaired by the Contractor, to the  
13 satisfaction of the Engineer, at no additional cost to the Contracting Agency. Such repairs  
14 may include removal and replacement of all affected materials.

### 15 16 **6-18.3(8) Shotcrete Finishing**

17 When the shotcrete facing is an interim coating to be covered by a subsequent shotcrete  
18 coating or a cast-in-place concrete fascia later under the same contract, the Contractor shall  
19 strike off the surface of the shotcrete facing with a roughened surface as specified in Section  
20 6-02.3(12). The grooves of the roughened surface shall be either vertical or horizontal.

21  
22 When the shotcrete facing provides the finished exposed final surface, the shotcrete face  
23 shall be finished using the alternative aesthetic treatment shown in the Plans. The  
24 alternatives are as follows:

#### 25 26 ***Alternative A***

27 After the surface has taken its initial set (crumbling slightly when cut), the surface shall  
28 be broom finished to secure a uniform surface texture.

#### 29 30 ***Alternative B***

31 Shotcrete shall be applied in a thickness a fraction beyond the alignment wires and  
32 forms. The shotcrete shall stiffen to the point where the surface does not pull or crack  
33 when screeded with a rod or trowel. Excess material shall be trimmed, sliced, or  
34 scraped to true lines and grade. Alignment wires shall be removed and the surface  
35 shall receive a steel trowel finish, leaving a smooth uniform texture and color. Once the  
36 shotcrete has cured, pigmented sealer shall be applied to the shotcrete face. The  
37 shotcrete surface shall be completed to within a tolerance of 1/2 inch of true line and  
38 grade.

#### 39 40 ***Alternative C***

41 Shotcrete shall be hand-sculptured, colored, and textured to simulate the relief, jointing,  
42 and texture of the natural backdrop surrounding the facing. The ends and base of the  
43 facing shall transition in appearance as appropriate to more nearly match the color and  
44 texture of the adjoining roadway fill slopes. This may be achieved by broadcasting fine  
45 and coarse aggregates, rocks, and other native materials into the final surface of the  
46 shotcrete while it is still wet, allowing sufficient embedment into the shotcrete to become  
47 a permanent part of the surface.

### 48 49 **6-18.4 Measurement**

50 Shotcrete facing will be measured by the square foot surface area of the completed facing  
51 measured to the neat lines of the facing as shown in the Plans.

1     **6-18.5 Payment**

2     Payment will be made in accordance with Section 1-04.1 for each of the following bid items  
3     when they are included in the proposal:

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5         “Shotcrete Facing”, per square foot.

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7         All costs in connection with constructing shotcrete facing as specified shall be included  
8         in the unit contract price per square foot for “Shotcrete Facing” including all steel  
9         reinforcing bars, premolded joint filler, polyethylene bond breaker strip, joint sealant, pvc  
10        pipe for weep holes, exterior surface finish, and pigmented sealer (when specified).